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**A PRELIMINARY INTERCOMPARISON BETWEEN NUMERICAL
UPPER WIND FORECASTS AND RESEARCH AIRCRAFT
MEASUREMENTS OF JET STREAMS**

By

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A Preliminary Intercomparison Between Numerical Upper Wind Forecasts and Research Aircraft Measurements of Jet Streams

M.A. Shapiro

During the past several years, research on the structure of extra-tropical jet streams has been carried out with direct measurements with instrumented research aircraft from the National Center for Atmospheric Research (NCAR). These measurements have been used to describe the wind, temperature, turbulence and chemical characteristics of jet streams.

A fundamental question raised by the objectives of the MERIT Program is one of assessing the potential value of existing NMC operational numerical forecast models for forecasting the meteorological conditions along commercial aviation flight routes so as to execute Minimum Flight Time tracks and thus obtain the maximum efficiency in aviation fuel consumption. As an initial attempt at resolving this question, the 12 hour forecast output from two NMC models was expressed in terms of a common output format to ease their intercomparison. The chosen models were (1) the Fine-Mesh Spectral hemispheric and (2) the Limited Area Fine Mesh (LFM) model. The spectral model is outputted over a 2-1/2, 2-1/2 lat./long. mesh over 10 model levels. The LFM has a horizontal grid resolution of approximately 1.5° by 1.5° and has a vertical resolution of 6 levels. The output from both models was interpolated to a 1-1/2 by 1-1/2 degree lat./long. grid at the 200, 250, 300 and 400 mb pressure levels over a selected

"window" which encompassed the contiguous United States. Examples from both models for 12 hour forecasts at 300 mb valid at 0000 GMT 4 April 1981 are shown in Figures 1a and 1b. Wind vector plots were made at every other grid point and the wind speed field was contoured to delineate the position of wind speed maxima and minima and regions of lateral wind shear. Figure 2 shows spectral verification analysis at 0000 GMT 4 April 1981. In addition, for more limited areas, the computer code gives wind vectors at each gridpoint of the interpolated mesh (see Figure 2a).

Intercomparisons were made for five cases in which highly accurate wind measurements were made with the NCAR Sabreliner valid at the time of the forecasts. Examples of the Sabreliner analyses used in this study are shown in Figure 3 (which is the verification analysis for forecasts shown in Figures 1a and 1b) and Figure 4. The preliminary results from the five cases may be summarized as follows:

- 1) Over the West Coast and inland to -120°W , the spectral model, because of its larger initialization data base over the oceans, gives more accurate upper-wind forecasts than the LFM.
- 2) Over the Central and Eastern United States the higher spatial (horizontal) resolution of the LFM gives (as observed) sharper, narrower jet streams with wind speeds that more closely resemble the observed winds. At jet cores, the spectral winds are on the order of 5 m s^{-1} less than the LFM winds.
- 3) Both models underestimate the jet stream wind speeds by as much as 25 m s^{-1} under anticyclonic curvature conditions.

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Straight jet streams or cyclonic jet streams seem to be forecast with greater accuracy.

4) There was fairly good agreement between observations and forecasts as to the location of jet cores and the wind direction for the chosen cases.

5) Neither model was able to resolve the 100 km scale to the cyclonic wind shear associated with narrow jets.

Results suggest the potential usefulness of the 6, 12 and 18 hour output from the LFM as the first guesstimate from which flight routes over the continental United States may be planned. Updating of this model data base with more recent pilot reports and satellite derived information would permit further "tuning" of the numerical product and hopefully lead to even more accurate upper wind forecasts.

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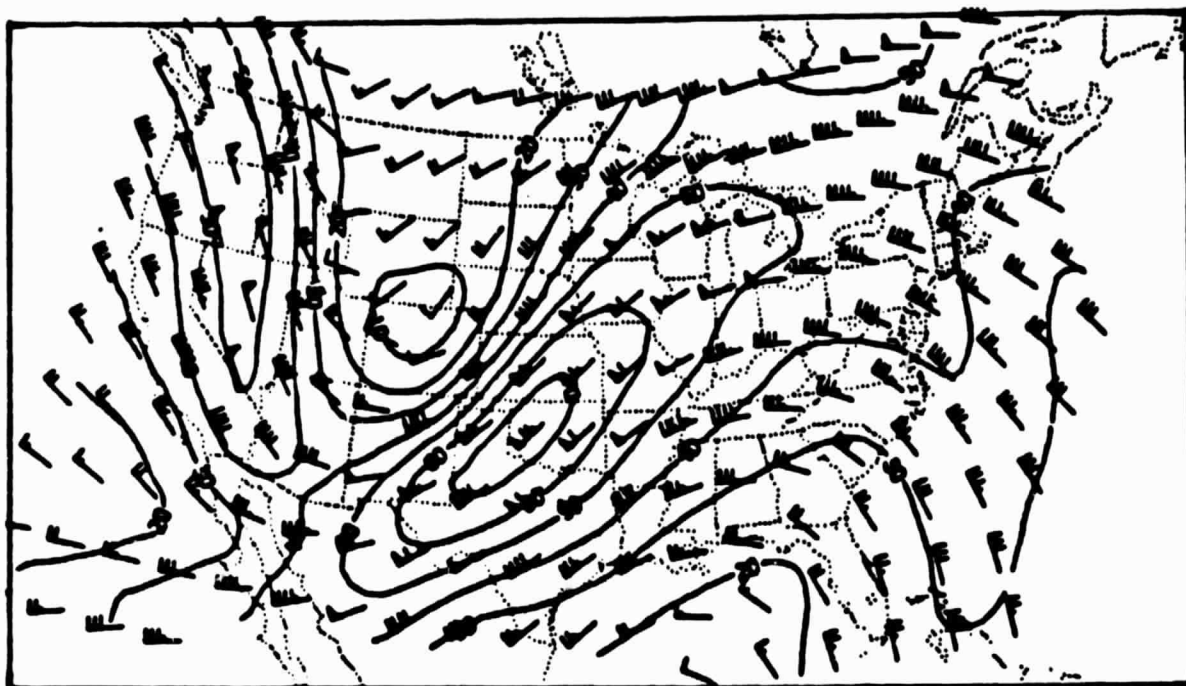


Figure 1a: LFM 12 hr. Forecast
300 mb 0000 GMT 4 April 1981

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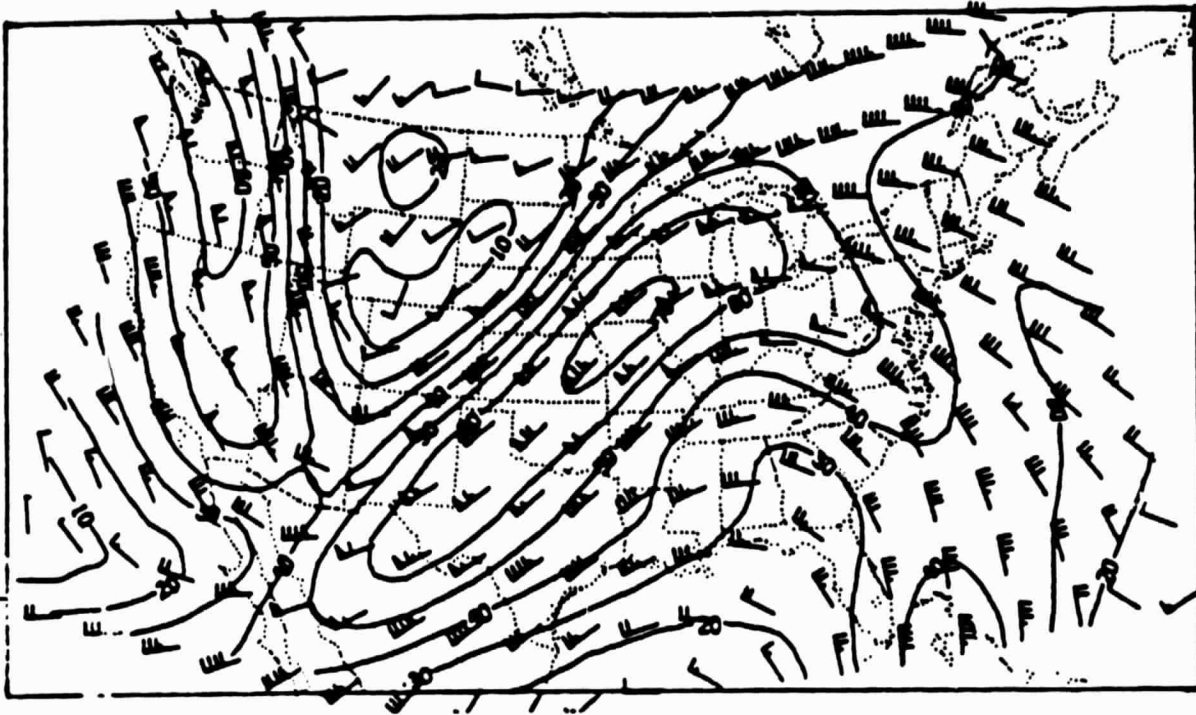


Figure 1b: Spectral 12 hr. Forecast
300 mb 0000 GMT 4 April 1981

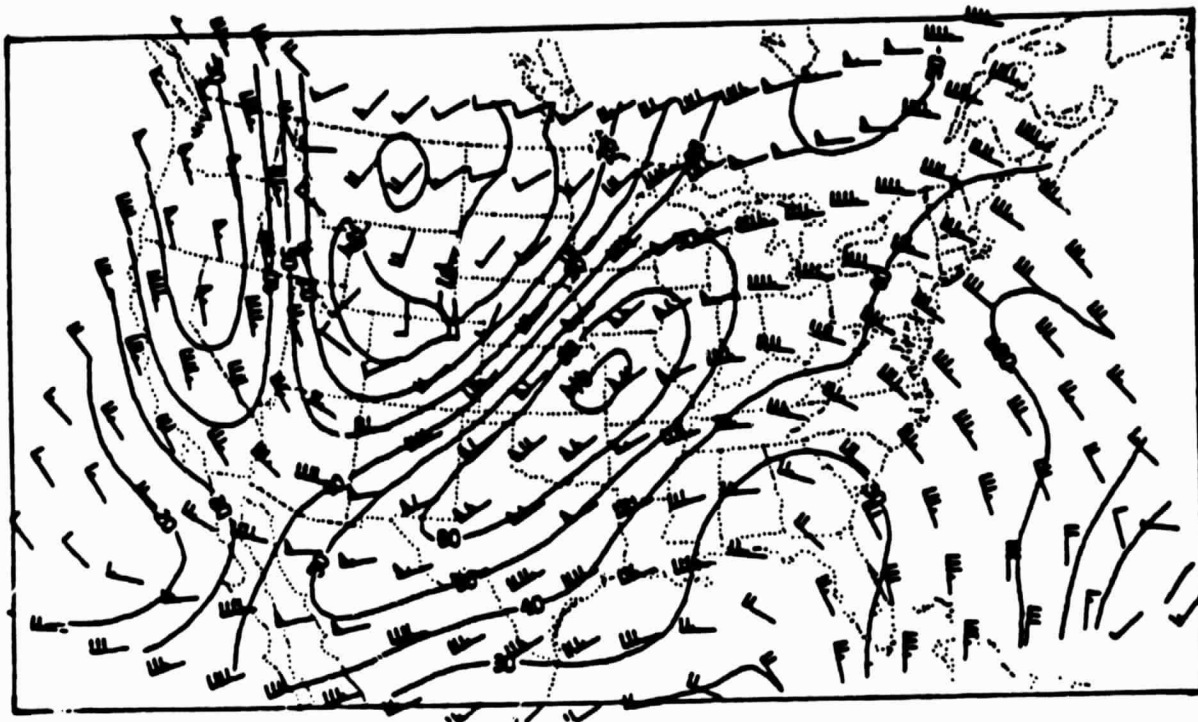


Figure 2: Spectral Initial 300 mb Winds
for 0000 GMT 4 April 1981

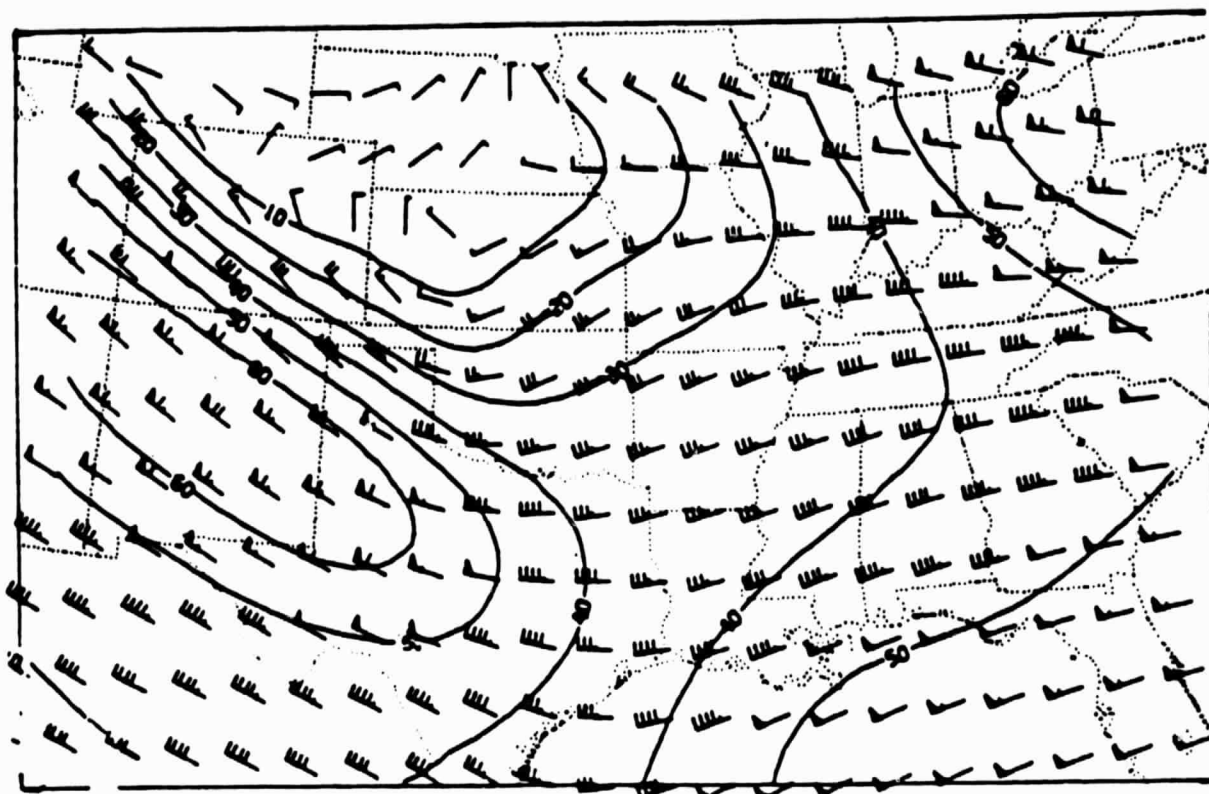


Figure 2a: 1.5 Degree Lat., Long. LFM
at 0000 GMT 17 April 1981

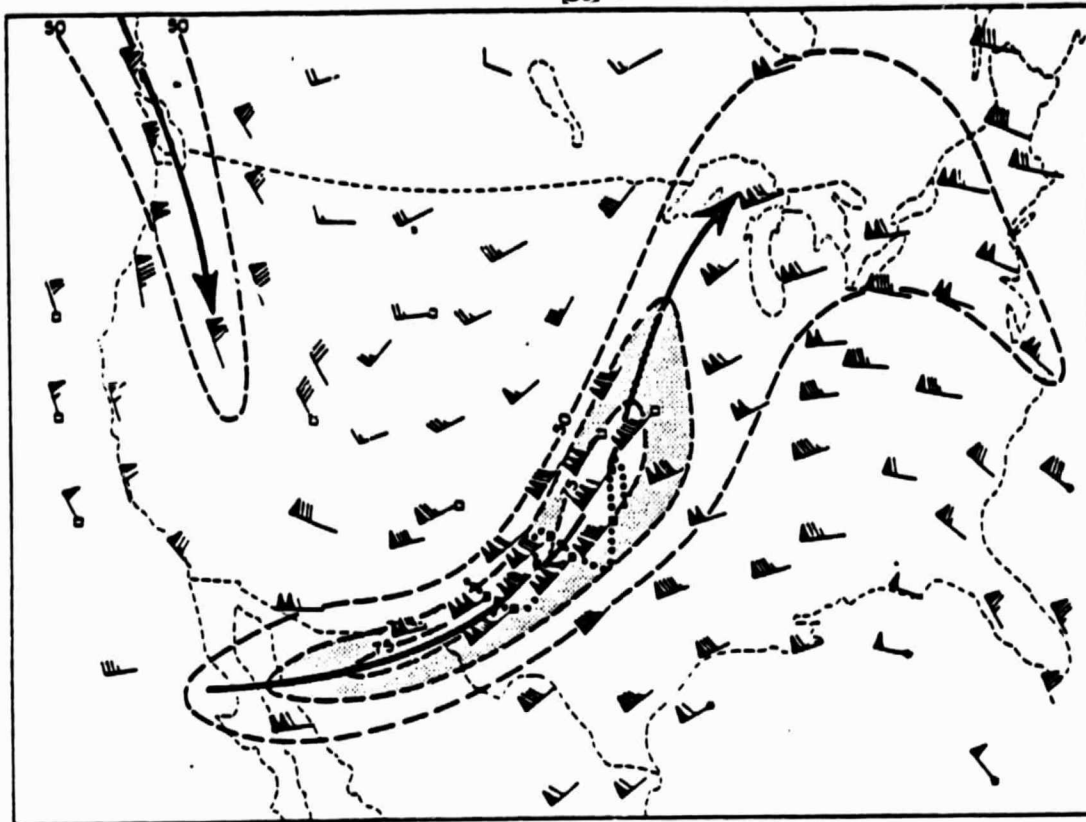


Figure 3: 250 mb wind speed analysis (m s^{-1} , dashed lines) at 0000 GMT 4 April 1981. Rawinsonde wind velocities (flag = 25 m s^{-1} , barb = m s^{-1} , half barb = 2.5 m s^{-1}), commercial airline wind reports (open box vectors), satellite cloud motion winds (asterisked vectors), Sabreliner research aircraft winds at 243 mb (closed box vectors). Jet stream axis (heavy solid arrow) and 62.5 to 75.0 m s^{-1} wind speed interval (stippled area) (after Shapiro and Kennedy, 1982).

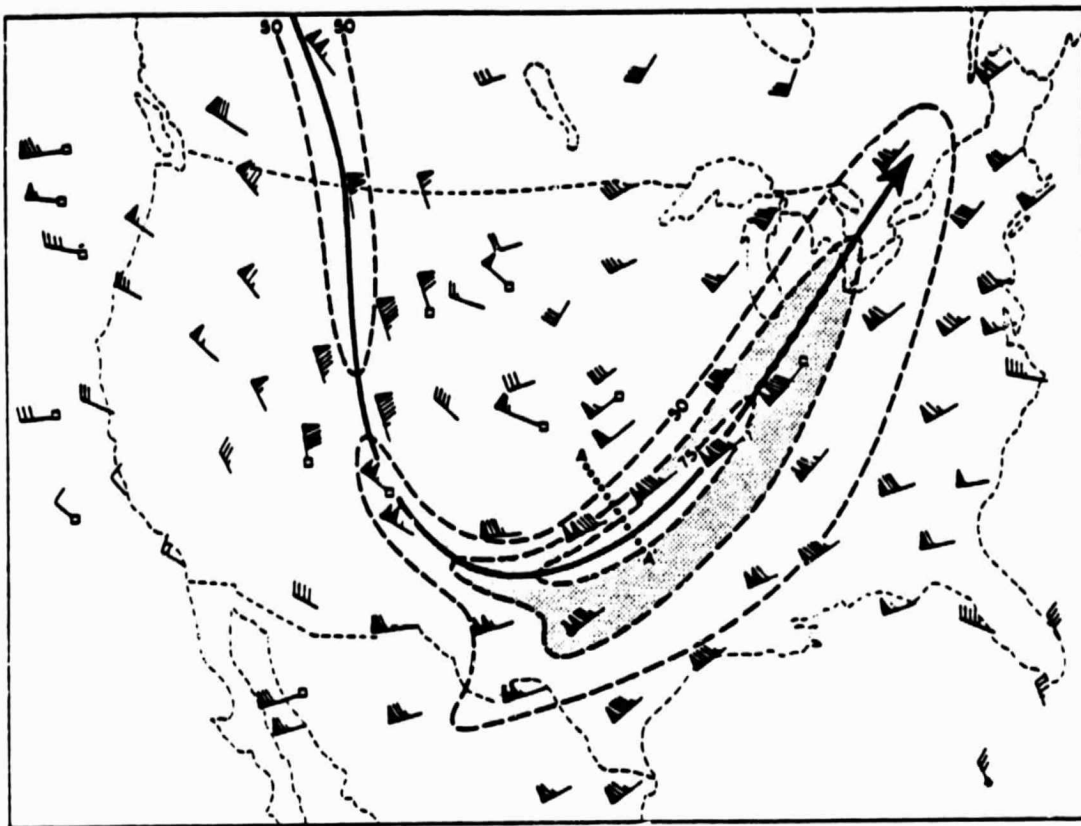


Figure 4: 250 mb wind speed analysis (dashed lines, m s^{-1}) at 0000 GMT 5 April 1981, Rawinsonde wind velocities (flag, 25 m s^{-1} ; barb, 5 m s^{-1} ; half barb, 2.5 m s^{-1}), commercial airline wind reports (open box vectors), satellite cloud motion (asterisked vectors), jet stream axes (heavy solid arrows) and 62.5 to 75.0 m s^{-1} wind speed interval (stippled area). AA' is projection line for Sabreliner aircraft data.